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(54) WEB TRANSPORTING AND COLLAPSING DEVICE

(71) We, E. I. DU PONT DE NEMOURS AND COMPANY, a Corporation organised and existing under the laws of the State of Delaware, United States of America, located at Wilmington, State of Delaware, United States of America, do hereby declare the invention for which we pray that a patent may be granted to us and the method by which it is to be performed to be particularly described in and by the following statement:—

This invention relates to a web material transporting and collapsing device and to a process for collapsing a moving web of material.

In manufacturing and handling webs of flexible material, simple and rapid removal of scrap is very important to efficient operation. In fact, the rate of manufacture or handling of wide webs of film material is often controllable by the ease with which scrap can be removed in case of a break in the web. Such removal, in the case of film web handling, includes a collapse or convergence of the web into a narrower form. For films of relative thin gauge, the collapsed or converged film can be characterized as a rope of material. For some film webs, particularly of heavy material, it has been found that pleating the web results in effective collapse and convergence. This invention, thus, relates to roping and pleating webs of material and to devices for performing the roping and pleating.

Pneumatic transport of webs, parts of webs, or small articles has been previously disclosed.

U. S. Patent No. 3,070,901, for example, discloses that webs can be guided along a certain path by means of a plurality of individual blower devices, some directing air transverse to the direction of travel. Louvers disclosed in that patent extend across the device and there is no disclosure of web material pleating.

U. S. Patent No. 3,705,676 discloses a conveyor which utilizes widely spaced air nozzles extending across an otherwise closed plenum chamber. The device is disclosed to be useful for removing web trim and for threading paper ribbon to start a paper machine. There is no disclosure of wide web transport or material collapse.

U. S. Patent No. 2,848,820 pertains to a web conveying device utilizing force from a gaseous medium. The device includes ducts for the gaseous medium having apposing vented faces forming a channel through which a web is conveyed. Louvers are not specifically disclosed and there is no hint of web collapse.

U. S. Patent No. 3,180,688 pertains to a conveyor with an air feed plenum having both perforations and slits, to provide lift and propulsion, respectively, to materials transported in the conveyor. The conveyor is walled with an open top. There is no web collapse.

U. S. Patent No. 3,181,916 pertains to a conveyor for small articles and includes an air plenum with one louvered surface. The louvered surface is walled with an open top and serves as the floor for article conveyance. There is no web material conveyance and no hint that webs, if conveyed, could be callapsed.

U. S. Patent No. 3,999,806 describes an air-driven conveyor for individual parts or articles wherein there are integral Y-shaped spur sections in the conveyor. The conveyor includes a deck with an underlying plenum section and holes in the deck, of certain configuration. The deck, in straight sections of the conveyor, includes a combination of lifting holes and propulsion slots and the spur sections have only propulsion slots. There is no mention of web transport or of collapsing materials transported.

According to the present invention we provide a web material transporting and collapsing device comprising:

an air feed plenum having an inlet end and an outlet end;

a multitude of slots with louvered openings in a surface of the plenum, said louvered openings directed toward the outlet end, so as, to apply longitudinal pneumatic force to a web of material positioned thereover to hold the web under tension and move the web in the direction of the

tension; and

means for applying transverse forces along said surface of the plenum to a web material transported in the device to collapse the web material.

Furthermore, a process is provided for collapsing a moving web of material comprising applying longitudinal pneumatic force to a wide web of the material to hold the web under tension; applying transverse forces to the web under tension to collapse the wide web; moving the web in the direction of the tension to continually apply longitudinal and transverse forces to the moving web.

In one form of the invention the device is intended to effect converging of the web material wherein said collapsing means comprises the provision of

a surface on the plenum decreasing in width from the inlet end to the outlet end, said surface having said multitude of slots with louvered openings.

There is also provided a web material waste handling apparatus comprising a wide web delivery means operatively engaged with such a transporting and collapsing device to receive and collapse wide web material, the device, in turn, being preferably operatively engaged with a comminuting means to receive collapsed web material. In one form of the process of the invention a moving web of flexible material is converged by applying longitudinal pneumatic force to a wide web of the material to hold the web under tension; applying balanced transverse forces toward the center of the web under tension over a predetermined length of the web to converge the wide web into a roped structure; and moving the web in the direction of the tension to continually apply longitudinal and transverse forces to the moving web; whereby the wide web is continually converged to a roped structure.

There is further and more specifically provided by the invention a transporting and collapsing device intended to effect pleating of the web material, wherein said collapsing means comprise the provision of first and second air feed plenums each having an inlet end and on outlet end, the first plenum having a transversely irregular surface, flat at the inlet end and progressing over the length of the surface to at least one peak at the outlet end, the second plenum having a transversely irregular surface mating with said surface of the first plenum and juxtaposed in a spaced-apart relation thereof and each irregular surface having a multitude of slots with louvered openings directed towards the outlet ends.

In one form of the process of the invention a moving web of material is pleated by applying longitudinal pneumatic force to a wide web of the material to hold the web under tension over a predetermined length of the web to collapse the wide web into a pleated structure; and moving the web in the direction of the tension to continually apply longitudinal and transverse forces to the moving web; whereby the wide web is continually collapsed to a pleated structure.

Embodiments of the invention are illustrated in the accompanying drawings wherein:

Fig. 1 is a top plan view of a material converger of this invention;

Fig. 2 is a cross-sectional view of a material converger of this invention;

Fig. 3 is a cross-sectional view of a material converger of this invention having two air-feed plenums;

Fig. 4 is a longitudinal cross-sectional view of a louvered portion of a material converger of this invention;

Fig. 5 is a cut-away section of the side of a material converger having both, an air feed plenum and a material feed plenum;

Fig. 6 is a cut-away section of the side of a material converger having an air feed plenum and material guides.

Fig. 7(a) is a side view representation of a web pleater of this invention;

Fig. 7(b) is a top view representation of a web pleater of this invention;

Fig. 8 is a perspective view of a web pleater of this invention;

Fig. 9 is an exploded perspective view of a web pleater of this invention;

Fig. 10 is a cross-sectional view of a louvered portion of a web pleater of this invention;

Fig. 11 is a view of the inlet end of a web pleater of this invention;

Fig. 12 is a view of the outlet end of a web pleater of this invention;

Figs. 13-16 are views of additional outlet ends of web pleaters of this invention.

Fig. 17 is a perspective view of another web pleater of this invention;

Fig. 18 is an exploded perspective view of a web pleater of this invention having compound surfaces;

Fig. 19 is an exploded end view of the device of Fig. 18.

Referring to Fig. 1, material converger 10 includes an inlet conveyor unit 11, a converger unit 12, and an outlet conveyor unit 13. Each unit includes slots 14 with louvered openings cut into surface 15 and arrayed at angles of 90 degrees or less with the direction of material transport. In the conveyor units 11 and 13, the slots 14 with louvered openings are cut generally perpendicular to the unit edges and perpendicular to the direction of material transport. In the converger unit 12, the slots 14 can be cut either perpendicular to or at an acute angle with the intended direction of mat-

erial transport. Using the center line 16 of the converger unit as a reference line, the slots 14 can be cut at an angle 17 of from about 30 to 90 degrees with angles of from about 40 to 60 being preferred for material convergers which utilize slots cut at acute angles. Slots 14 in converger unit 12 need not be perpendicular to the unit edges and slots cut at different angles can be used in a single unit. Web 18, shown to be transparent, is delivered to converger 10 from a wide web delivery means, not shown. In operation, the web continuously traverses inlet conveyor unit 11 in flat form, converger unit 12 under collapsing forces to yield a rope, and outlet conveyor unit 13 in roped form. In roped form, web 18 can be easily handled such as in a web material waste handling apparatus, the roped structure can be introduced directly into a comminuting means, not shown.

Referring to Fig. 2, material converger 10, including inlet conveyor unit 11, converger unit 12, and outlet conveyor unit 13, is represented in a cross-sectional side view. In these Figures, slots 14 in surface 15 are represented in an oversized manner to indicate the direction of louver openings. The body of inlet conveyor unit 11 is an air feed plenum and, under operational air pressure, air is forced through the slots 14. In the same way, air is forced through the slots 14 in the converger unit 12 and the outlet conveyor unit 13. Air, thus moving through slots 14 provide longitudinal pneumatic forces to hold web 18 under tension; and, in the case of slots 14 cut at an angle, the air also provides transverse forces which, when balanced on each side of a center line on surface 15, converge and collapse web 18. Increase in depth of the plenum with decreasing width can be used to aid in maintaining a balanced air flow through the material converger. The width of surface 15 in conveyor units is constant from end to end, and in converger units decreases in the direction of material transport.

Fig. 3 represents a cross-sectional view of a material converger 10 with two air feed plenums. Individual elements of the converger correspond to elements previously identified in Fig. 2. The material converger 10 of Fig. 3 includes two single plenum convergers positioned surface-to-surface (15-15) and spaced apart to leave channel 19 through which web material is conducted and converged. Channel 19 can be made to increase in depth with decreasing width to accommodate transport of web material as the web is converged into a roped form.

Fig. 4 represents a cross-sectional view cut through slots 14 in a portion of surface 15 of a converger unit 12. Arrow 20 indicates the direction of air flow and consequent direction of material transport under operational air pressure.

Fig. 5 represents a partially cut away side view of a material converger 10 including inlet conveyor unit 11a, converger unit 12a, and outlet conveyor unit 13a. The bodies of the conveyor unit 11a and 13a and the converger unit 12a in this Fig. 5 include air feed plenum 21 with material feed plenum 22 mounted thercon. Materal feed plenum 22 is shown to have increased depth with decreased width to facilitate handling of wide web material in roped form. Surface 15 forms a common wall between air feed plenum 21 and material feed plenum 22.

Fig. 6 represents a partially cut away side view of a material converger including inlet and outlet conveyor units 11 and 13, converger unit 12, surface 15 and slots 14, as previously described. The material converger of this Figure also includes material guides 23 which are walls extending upward from and defining the lateral edges of the surface 15.

The material guides serve a dual purpose. First, the guides prevent web material from running off of the converger during operation, especially during start-up while threading a web through the converger device. Second, the guides aid in converging, collapsing, and roping web material moving through the conveyor by providing transverse forces toward the center of the web material. The aid provided by material guides in collapsing web material is especially important in operation of converger units having slots perpendicular to the direction of material transport and in handling web materials having a stiffness too great for ready collapse by air forces alone.

Convergers having slots cut perpendicular to the direction of material transport are constructed with material guides along the converging sides of the unit. Convergence or roping of a moving web is accomplished by contact of the web with the material guides. In such convergers, web roping is dependent upon the combination of transporting force provided by air passing the louvers and converging force provided by physical contact between the web and the material guides.

Convergers having angled slots can also be used with material guides along the converging sides of the unit. Such convergers are ideally suited for roping webs of film having a stiffness such that the material guides provide converging forces by contact between the film and the material guides.

Convergers having slots cut at an angle with the direction of material transport can

be used without material guides, if desired. In such conveyors, roping of a moving web is accomplished by angled forces from the louver openings.

Material guides can be straight or curved, perpendicular or angled with the louvered surface. The guides can be walls of any effective height depending on the requirement of a particular use; such heights ranging from a mere rib tracing the pattern of the louvers to curved walls angled upward and together to yield a closed material feed plenum. Material guides can be formed from louvered surfaces angled upward and equipped as air plenums such that the material guides also operate as conveying surfaces.

Referring to Figs. 7(a) and 7(b), web pleater 24 is shown in a simplified representation with flat web 18 entering the pleater and collapsed, pleated, web 18(a) leaving the pleater.

Fig. 7(a) represents a side view of pleater 24 including first air feed plenum 25 and second air feed plenum 26. The air feed plenumse are juxtaposed in spaced-apart relation to leave a channel denoted by inlet end 27 and outlet end 28. Flat web 18 enters pleater 24 at inlet end 27. As the web is transported through pleater 24, it is, itself, pleated and emerges at outlet end 28 as pleated web 18(a).

Fig. 7(b) represents a top view of pleater 24 looking down on air feed plenum 25. Phantom lines 29 indicate the location of pleats formed in flat web 18 as it progresses through the channel from inlet end 27 to outlet end 28 emerging as pleated web 18(a).

Fig. 8 is a perspective representation of web pleater 24 with flat web 18 passing into inlet 27 and pleated web 18(a) passing out of inlet end 28. Air feed plenum 25 and air feed plenum 26 are juxtaposed and have opposing surfaces which are fan pleated commencing at the inlet end with a flat surface and progressing to the outlet end with full surface pleats. The pleats of each surface mate in a spaced-apart relation. Pleat trough 30 and pleat peak 31 in plenum 25 mate with pleat peak 32 and pleat trough 33 in plenum 26 to yield a channel for the transport of web material.

Fig. 9 is an exploded perspective representation of web pleater 24 showing air plenums 25 and 26 with transversely irregular surfaces 34 and 35. While a variety of transversely irregular surfaces 34 and 35 can be utilized, for purposes of description, the surfaces shall be sometimes characterized herein as fan pleated. The inlet edge 36 of surface 35 on plenum 26 is substantially flat. The outlet edge 37 of surface 35 on plenum 26 is irregular. Surface 35 is, thus, pleated with folds which commence at the inlet edge 36 and progress over the length of surface 35 to the outlet edge 37. Such fan pleated surface 35 of plenum 26 is matched by fan pleated surface 34 of plenum 25 to mate therewith when the plenums are juxtaposed in surface-to-surface spaced-apart relation.

Although not a requirement of the pleating device of this invention, it is preferred and generally the case that the distance along the flat inlet edge of a fan pleated surface is about equal to the distance along the pleated outlet edge of that surface.

Fan pleated surfaces 34 and 35 are shown with a representation of slots 38 cut into the surface. Slots 38 are used to direct a gas flow from inside plenums 25 and 26 along the surfaces 34 and 35 toward the outlet edges of those surfaces. Gas, thus directed, exerts transporting forces on web material located between the plenums. Web material, under the influence of the gas transporting forces, is contacted by the pleated plenum surfaces which exert transverse forces on the web to cause orderly web collapse, herein termed pleating.

The source of gas and pressure means for directing the gas are not shown. Gas can be supplied by fans or other means and can be introduced into the plenums by any means and at any locations. The plenums can have closed ends as shown in Fig. 8 or open ends as shown in Fig. 9. Web pleating plenums having open ends can be operatively joined with plenums from other pneumatic web conveying devices. The plenums must be otherwise sealed to permit an inside-to-outside pressure differential adequate to maintain flow of gas through the slots at a velocity greater than the intended web velocity for web transport. Gas supply can be introduced at a plenum end or through holes in any flat plenum surface. Gas supply and gas velocity should be adjusted to be nearly the same for mating plenums in order to balance forces on the web material in the channel between the plenums.

If desired or required, vents or other openings for emergent gas can be provided in addition to the slot openings. For example, the web pleater can be joined with pneumatic conveyors which conveyors can supply gas pressure at the pleater inlet ends and can utilize gas pressure at the pleater outlet ends.

Fig. 10 shows a cross-sectional view of a representative fan pleated surface of a web pleater, for example, surface 35, sectioned through slots 38. Arrow 39 indicates the direction of gas flow and consequent direction of web transport under operational gas pressure.

Fig. 11 is a representation of a shape for

an inlet end 27 of a web pleater of this invention. The inlet end 27 is bounded by flat inlet edges of plenum surfaces 34 and 35 and represents the channel for introducing flat web into the web pleater. While not necessary for operation of the web pleater, it is sometimes advantageous to locate shoulders 40 at each end of inlet 27. Edges of some scrap web material are sometimes stiff and unmanageable and provision for enlarged edge channels over the length of the pleating device accommodates such stiff material.

Fig. 12 is a representation of a shape for an outlet end 28 of a web pleater of this invention. The outlet end 28 is bounded by pleated outlet edges of plenum surfaces 34 and 35 and represents the channel for releasing pleater web from the web pleater. The channel of this Fig. 12 exhibits two peaks and results in collapse of a flat web to about one-half of its original width. The degree of flat web collapse depends, generally, upon the number of peaks and the length of channel between peaks.

Fig. 13 is a representation of an outlet end 28 having one peak and resulting in collapse of a flat web to about one-half of its original width.

Fig. 14 is a representation of an outlet end 28 having three peaks and Fig. 15 is a similar representation demonstrating that the peaks can be truncated or rounded. Fig. 16 is a representation of an outlet end 28 having three peaks in a channel made from circular elements.

Fig. 17 is a perspective representation of a web pleater 41 with flat web 18 passing into inlet end 42 and pleated web 18(a) passing out of inlet end 43. Air feed plenum 44 and air feed plenum 45 are juxtaposed and having opposing surfaces with a single, round, pleat commencing at inlet end 42 with a flat surface and progressing with increasing curvature to the outlet end 43. Air plenum 44, at the outlet end 43, is shown to have an inverted "U" shape. Air plenum 45, at the outlet end 43, is shown to be a solid shape with one surface rounded to mate with the opposing surface of plenum 44. The solid shape could, of course, be an inverted "U" shape. Air plenums 44 and 45, at the outlet end 43, can have more than one peak, such as by having the shape of an "M".

Fig. 18 is an exploded perspective representation of a web pleater 46 showing air plenums 47 and 48 with transversely irregular surfaces 49 and 50. Transversely irregular surfaces 49 and 50 have compound curves wherein the transverse pleating curve progressively increases over the length of the surfaces and the surfaces themselves are curvilinear along their length. By curvilinear, is meant that a line 1 from a point 54 along inlet edge 51 to a corresponding point 55 along outlet edge 52 is a curved line. In this drawing, to enable more complete understanding, phantom lines are inserted to provide indication of all edges of the pleater. The inlet edge 51 of surface 50 on plenum 48 is substantially flat; and the outlet edge 52 of plenum 48 is irregular and directed in a plane different from that of the inlet edge 51. Surface 50 is, thus, pleated with a single, rounded, pleat in a compound curvilinear surface which commences at the inlet edge 51 and progresses over the length of surface 50 to the outlet edge 52. Such pleated surface 50 of plenum 48 is matched by pleated surface 49 of plenum 47 to mate therewith when the plenums are juxtaposed in surface-to-surface spaced-apart relation. A web to be collapsed, when transported through the assembled pleater of Fig. 18, is pleated into the shape of an inverted "U" and is also twisted into a different plane.

The transversely irregular, fan pleated surfaces of the web pleater of this invention can include one pleat or several and the pleats can be peaked with sharp edges or can be truncated or round.

In operation, a gas pressure is provided in the plenums of the invention by means of fans or the like. For reasons of economy, air is the gas most often used although any other suitable gas or combination of gases would be effective. Additives can be combined with the gas to accomplish some treatment and the gas can be heated or cooled to alter temperatures or to dry pleated material. The gas pressure must be sufficient to move gas through the plenums at a velocity greater than the desired rate of web transport.

Web transport, in the case of scrap removal, can be required to be as great as about 1000 meters per minute. Due to the ease of web handling provided by the devices of this invention, the devices are also useful at low web transport speeds, for instance, as slow as about 15 meters per minute.

The devices of this invention are self-starting. In the case of the web pleater, introduction of an end length of web material into the pleater commences collapse and transport of the web.

In the case of the material converger, the self-starting capability is improved if the inlet end of the device includes at least two air feed plenums having surfaces in juxtaposed, spaced-apart, relation, with the louvered openings directed in concert. It has also been found helpful to fit the outlet end of the material converger with a material feed plenum or an air feed plenum to assist in continuous operation through gaps in material supply caused by breaks in

the web. Self-starting is an important feature where nearly instantaneous web scrap removal is necessary in high speed film handling processes.

Collapse and transport of web materials can be conducted with the surface of the device in any attitude — vertical, horizontal, or any intermediate position — and in a flat or curvilinear shape. The material converger can be effectively operated with a surface which exhibits curve either to the right or to the left on the horizontal plane and curve of either inside or outside radius on the vertical plane.

Louvers in the surface of the plenums are formed from slots cut in the surface and opened in the direction of intended material travel. Louvers direct the gas nearly flat along the surface. The louver openings are preferably below and are nearly perpendicular with the surface. Arrays of louvers can be in any pattern and can have any length and spacing within the following general limits: The louvers are less than 25 centimeters and preferably from 2 to 15 centimeters long. The length of the louvers is less than one-fourth the width of the total surface. Each louver should have more than one neighboring louver at least one-fourth louver length but less than three louver lengths away.

Louver length and spacing is important to maintain a stable and rapid movement of web material. Louvers which are too long or which are spaced too closely permit an excessive flow of gas from the plenum resulting in excessively reduced gas pressure farther along the plenum. Such excessively reduced gas pressure provides inadequate force for continued pleating and transport of the material. Louvers which are too short or which are spaced too far apart prevent gas flow adequate to provide material collapse and transport.

As a general rule, louvers at the inlet end of the device should be relatively closer together than louvers at the outlet end. Such progressively greater spacing between louvers is believed to aid in balancing gas flow through the device and in developing a higher initial tension in web material entering the device.

Mating plenums spaced apart to make the web pleater of this invention are spaced near enough to afford adequate pneumatic transporting forces to move the web and are spaced far enough to provide room for movement of the web without hang-up in the plenum surfaces. The preferred distance between the plenums is different for different web materials and operating conditions. The distance can vary from one pleater to another within a range of about 2 to 25 centimeters. Distances of from 5 to 15 centimeters have been found particularly suited for pleating webs of polyethylene terephthalate from 25 to 30 microns in thickness.

In the case of pleaters having compound surfaces, distances between the plenums can be as much as 40 centimeters. A distance of 30 to 35 centimeters has most often been used.

Web material which can be collapsed and transported by the devices of this invention includes fibrous material such as paper, metals such as aluminum foil, synthetic polymeric material such as polymer film and spunbonded polymer webs, and the like. The devices are particularly suited to collapsing and transporting webs of material having indefinite length. Webs to be collapsed must only exhibit adequate flexibility for transporting through the device.

When it is desired to pleat a web and simultaneously twist the web out of its initial plane, pleaters having compound surfaces are useful and such pleaters are particularly useful when the web to be pleated and twisted is of a relatively thick material. Pleaters having compound surfaces are also particularly useful in collapsing webs which are not of uniform thickness or stiffness across the web. Such webs having especially thickened edges are more easily collapsed by a pleater having compound surfaces because the compound surfaces cause the web edges to be buckled and twisted about the longitudinal axis of the web.

As a specific example of the present invention material converges having angled slots and material guides can be used to rope webs of polyethylene terephthalate film as thick as about 125 microns (5 mils). Polyethylene terephthalate film as thick as about 50 microns (2 mils) can be roped and transported using a material converger having angled slots either with or without material guides or using a material converger having slots perpendicular to material transport and fitted with material guides.

As another specific example of this invention, web pleaters having as few as one to as many as six or more pleats can be used to collapse webs of polyethylene terephthalate at least 350 microns (14 mils) thick. While web pleaters are useful for handling a wide range of materials, including films as thin as about 25 microns (1 mil), the web pleater finds particular application for pleating relatively heavy webs which are only difficultly collapsed by other means. Examples of such relatively heavy webs would be polyethylene terephthalate greater than about 125 microns (5 mils) thick and spun-bonded polypropylene fabric about 116 g/m^2 (3.5 ounces/yd^2) in weight.

A preferred slot configuration for the devices involves slots about 5 centimeters

long spaced 5 centimeters apart in the direction of web travel with slot ends 5 centimeters apart in the transverse direction. Louvers formed from slots in this configuration can have an opening about 0.15 centimeter wide.

The degree of web collapse, expressed as a ratio of initial web width to distance across collapsed web can be from less than two to greater than seven. Other than as a matter of practicality, there do not appear to be actual limits to the ratio. With wide webs collapsed over long distances or at sharp angles, higher degrees of collapse can be obtained.

For example, webs as wide as about 3.75 meters can easily be pleated to less than about 1 meter while being transported at more than 200 meters per minute; and webs as wide as six meters have been easily roped to less than two meters while being transported at more than 500 meters per minute.

The number of pleats to which a web is subjected for collapse is important only insofar as it is important to reduce the height of the pleated web. For example, a web which has one pleat emerges from the web pleater with a height equal to about one-half of the initial web width while a web with four pleats will have a height of only about one-fourth of the initial web width. Height of the pleated web is important on occasions wherein it is desired to introduce pleated scrap webs directly into a shredding or chipping device to comminute the scrap into an efficient form for recycling processes. In such a case, the pleated web must be of a size to fit into the mouth of the shredder or chipper.

WHAT WE CLAIM IS:

1. A web material transporting and collapsing device comprising:

an air feed plenum having an inlet end and an outlet end;

a multitude of slots with louvered openings in a surface of the plenum, said louvered openings directed toward the outlet end, so as, in use, to apply longitudinal pneumatic force to a web of material positioned thereover to hold the web under tension and move the web in the direction of the tension; and

means for applying transverse forces along said surface of the plenum to a web material transported in the device to collapse the web material.

2. A device according to Claim 1, intended to effect converging of the web material wherein said collapsing means comprises the provision of

a surface on the plenum decreasing in width from the inlet end to the outlet end, said surface having said multitude of slots with louvered openings.

3. The device of Claim 2 wherein lateral edges of the surface are defined by material guides.

4. The device of Claim 2 or 3 wherein at least some of said slots are arranged at an acute angle with a reference line from the center of the inlet end to the center of the outlet end.

5. The device of Claim 4 wherein the acute angle is from 40 to 60 degrees.

6. The device of Claim 2 or 3 wherein the slots are arranged perpendicular to a reference line from the center of the inlet end to the center of the outlet end.

7. The device of any one of Claims 2 to 6 including a material feed plenum mounted on the air feed plenum and having said surface as a common wall between the air feed plenum and the material feed plenum.

8. The device of any one of Claims 2 to 6 comprising a plurality of air feed plenums arranged such that the surfaces are juxtaposed in spaced-apart relation and the louvered openings are directed in concert.

9. A device according to Claim 1 intended to effect pleating of the web material, wherein said collapsing means comprise the provision of first and second air feed plenums each having an inlet end and an outlet end, the first plenum having a transversely irregular surface, flat at the inlet end and progressing over the length of the surface to at least one peak at the outlet end, the second plenum having a transversely irregular surface mating with said surface of the first plenum and juxtaposed in a spaced-apart relation thereto and each irregular surface having a multitude of slots with louvered openings directed towards the outlet ends.

10. The device of Claim 9 wherein the mating first and second plenum surfaces are between 2 and 25 centimeters apart.

11. The device of Claim 9 or 10 wherein the distance along the plenum inlet ends is about equal to the distance along the plenum outlet ends.

12. A device according to Claim 9, 10, or 11 comprising

a fan pleated surface on the first plenum, flat at the inlet end and progressing over the length of the surface to at least one peak at the outlet end; and

a fan pleated surface on the second plenum mating with the surface of the first plenum and juxtaposed in spaced-apart relation thereto.

13. The device of Claim 9, 10, 11 or 12 wherein the plenum outlet ends have three peaks.

14. A device according to any one of Claims 9, 10 or 11 wherein the plenum outlet ends have a single peak.

15. The device of Claim 14 wherein the single peak is round.

16. The device of Claim 9, 10. 11, 14 or 15 wherein the transversely irregular surfaces are curvilinear along their length.

17. A web material waste handling apparatus comprising:

a wide web delivery means and operatively engaged therewith, a transporting and collapsing device according to any one of the preceding claims.

18. A web material waste handling apparatus according to Claim 17, further comprising

a comminuting means operatively engaged with the transporting and collapsing device to receive collapsed web material.

19. A process for collapsing a moving web of material comprising:

applying longitudinal pneumatic force to a wide web of the material to hold the web under tension;

applying transverse forces to the web under tension to collapse the wide web;

moving the web in the direction of the tension to continually apply longitudinal and transverse forces to the moving web;

whereby the wide web is continually collapsed.

20. A process according to Claim 19 wherein the transverse forces are applied as balanced transverse forces toward the center of the web applied under tension over a predetermined length of the web to converge the wide web into a roped structure, whereby the wide web is continually converged to a roped structure.

21. A process according to Claim 19 wherein the transverse forces are applied as transverse pleating forces applied to the web under tension over a predetermined length of the web to collapse the wide web into a pleated structure, whereby the wide web is continually collapsed to a pleated structure.

22. A process for handling a web material substantially as hereinbefore described with reference to the accompanying Drawings.

23. A web material transporting and collapsing device substantially as shown in Figures 1 to 6, Figures 7a to 16 and Figures 17 to 19 of the accompanying Drawings and described herein with reference thereto.

24. Web material which has been collapsed by the process of any one of Claims 19 to 22.

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Sheet 1

FIG. 1

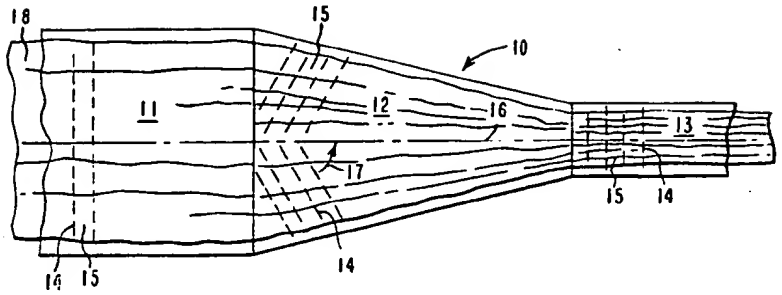

FIG. 2

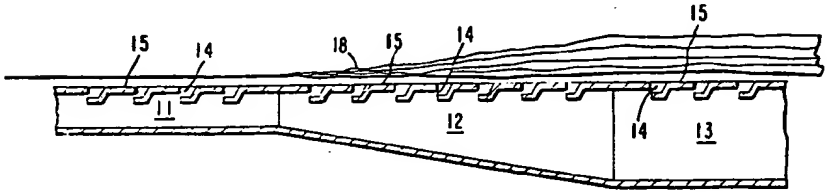

FIG. 3

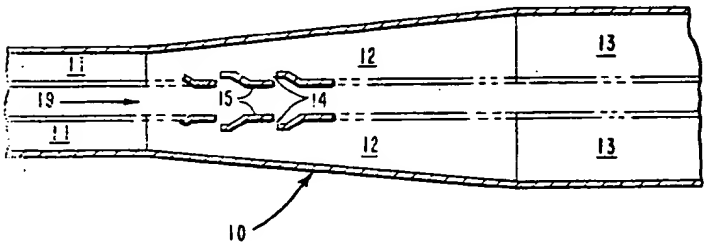

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FIG. 4

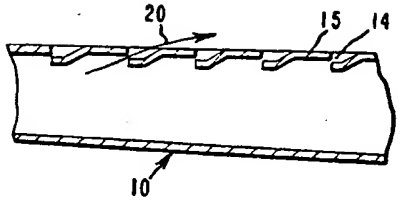

FIG. 5

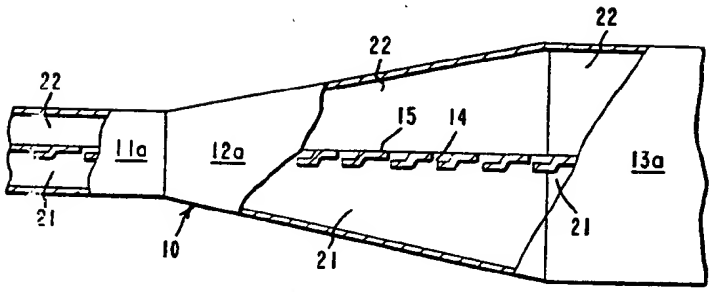

FIG. 6

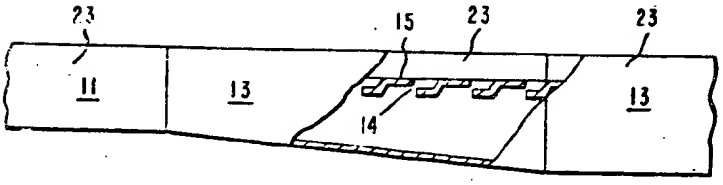

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FIG. 7a

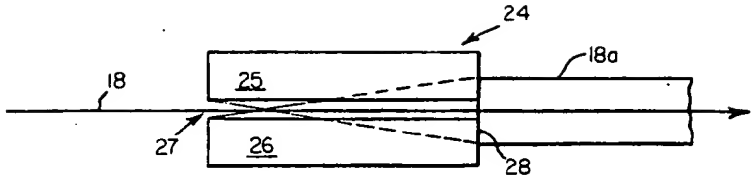

FIG. 7b

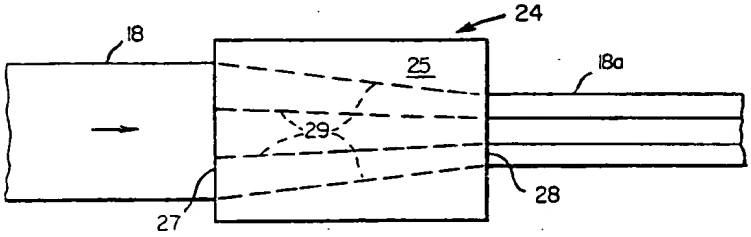

FIG. 8

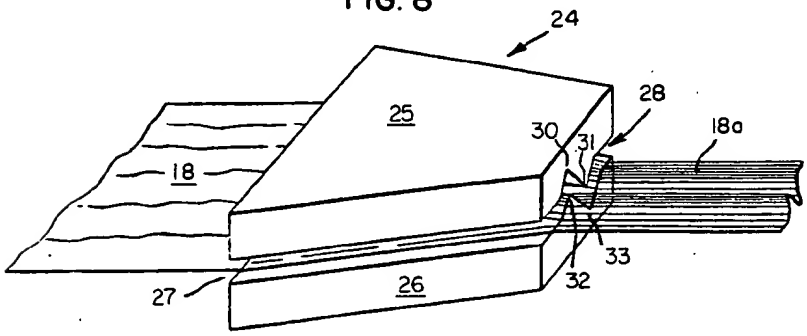

FIG. 9

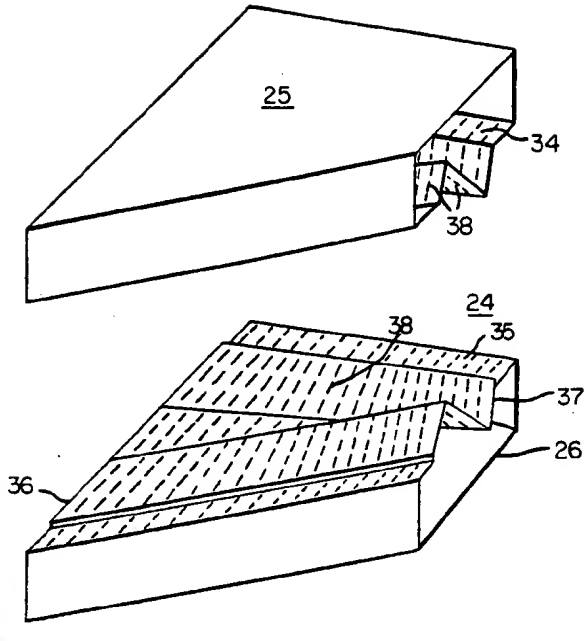

FIG. 10

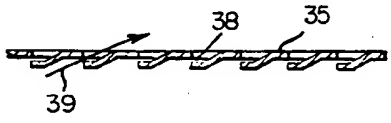

FIG. 11

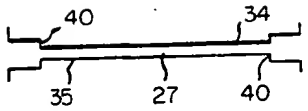

FIG. 12

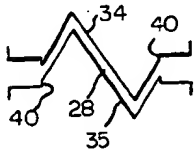

FIG. 13

FIG. 14

FIG. 15

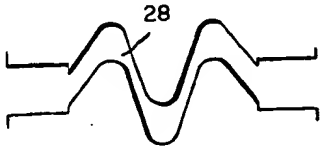

FIG. 16

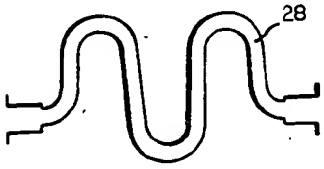

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FIG. 17

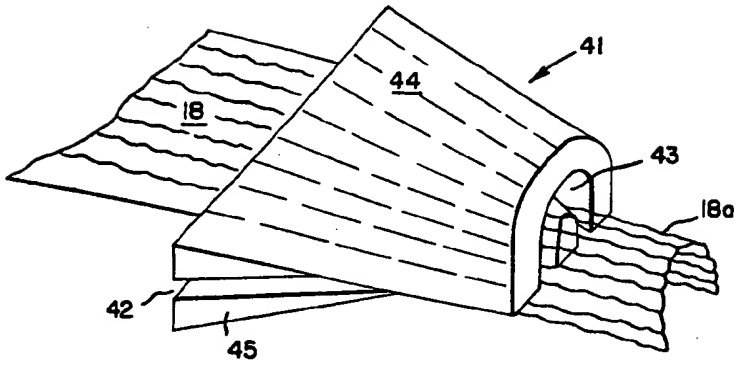

FIG. 19

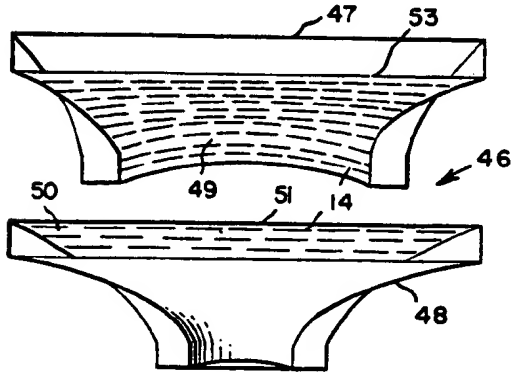

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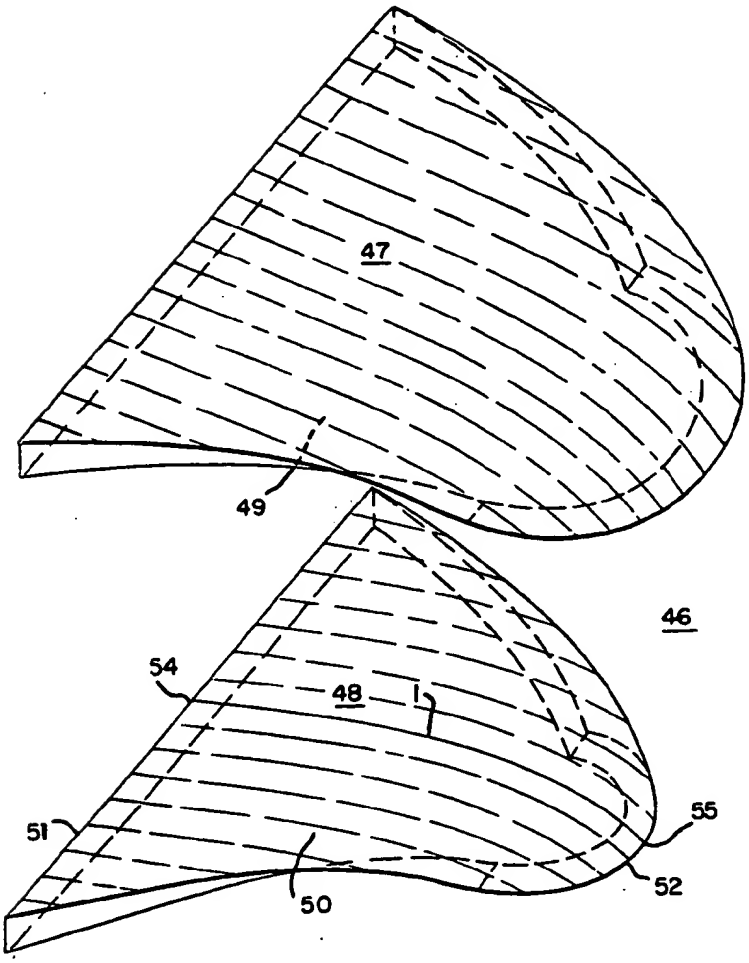
FIG. 18



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